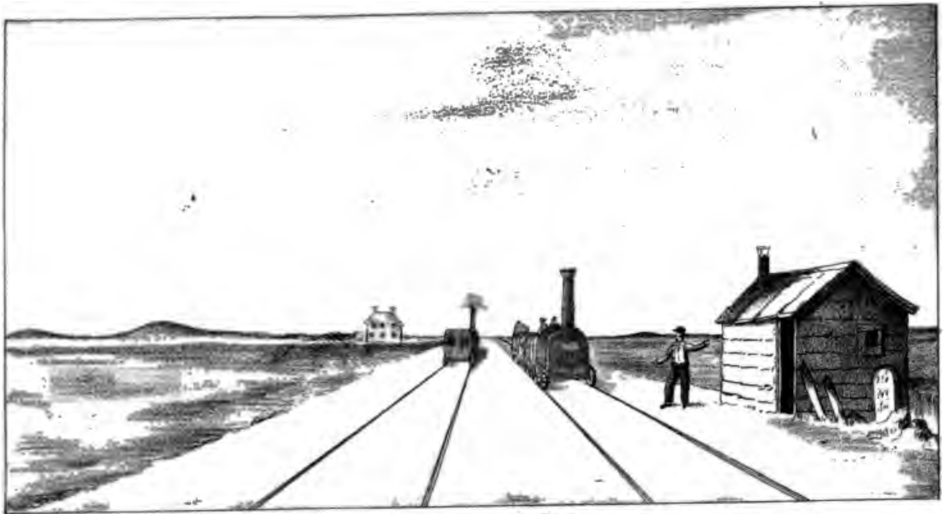

Pendleton's Lithography, Boston.

CHAT MOSS.

DESCRIPTION

OF THE

RAIL ROAD

FROM

LIVERPOOL TO MANCHESTER.

BY P. MOREAU, ENGINEER.

TOGETHER WITH A

HISTORY OF RAIL ROADS,

AND MATTERS CONNECTED THEREWITH,

COMPILED

BY A. NOTRÉ,

FROM THE WORKS OF MESSRS. WOOD AND STEPHENSON,
AND FROM INFORMATION FURNISHED BY THE LATTER.

Nil mortalibus arduum est. HOR.

TRANSLATED FROM THE FRENCH,

BY J. C. STOCKER, JR. CIVIL ENGINEER.

BOSTON:
HILLIARD, GRAY, AND COMPANY.
1833.

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Freeman & Bolles, Printers.

TRANSLATOR'S PREFACE.

THERE are few subjects which now occupy the public mind so generally as that of Rail Roads, and very few at the same time are so imperfectly understood. The translator of the following pages has resolved to give them publicity, not with a view of throwing any *new* light upon the subject, but solely for the purpose of giving the information necessary for those who have never examined it, to form a perfectly correct idea of the progress, gradual improvement, &c. of Rail Roads. The numerous works of Messrs. Wood, Stevenson, Tredgold and others are generally too voluminous and abstruse to be consulted by any but professional men and those more immediately engaged in Rail Road operations. The editor of this work has culled from this mass, that which he considered sufficient to exhibit all the ordinary operations of Rail Roads, and has explained constructions, &c. in a plain and intelligible manner, avoiding all technical nicety as much as possible. Numbers of our fellow citizens have made the trip from Liverpool to Manchester on the Rail Road, but the history of it is known to very few, and although the names of Chat Moss, Edge

Hill, &c. &c. are perfectly familiar to the ear, yet their relative situation is but little understood. The journey from Liverpool to Manchester in the latter part of these pages, is thought to give an excellent idea of the situation of many parts of the route, and of the immense quantity of labor expended upon it. The translator would remark that many parts of the original have been omitted, which have been extensively circulated in the public prints, and respectfully consigns this work to those who, not having leisure or inclination, to enter into a study of the subject, would willingly acquire a general knowledge of so interesting a science.

PREFACE OF THE EDITOR.

Convinced of the utility of rendering an acquaintance with Rail Roads more general, especially at the present moment, when many of these admirable methods of communication are being adopted in France, I offer to the public an account (taken from my notes on the different works of the kind in England and from the publications of Messrs. Wood and Stephenson,) short, indeed, but sufficient to give a satisfactory idea of the gradual progress of this science (industrie), to the completion of the Liverpool and Manchester Rail Road.

The plates which I have determined to publish at the same time, appear to me necessary to give a just conception of different constructions, which cannot be done by description alone.

My sole end is to hold up to public view the advantages which agriculture, commerce, and manufactures will derive from the encouragement given to them by increased facilities of transportation, and I shall feel myself amply rewarded, if I can contribute in any degree to the encouragement of a generous emulation, without which our rivals of all ages will enjoy over us the immense advantage of having abridged both time and space, by increasing the facility of communication.

HISTORY OF RAIL ROADS.

INTRODUCTION.

THE existence of Rail Ways is scarcely known in France, and especially in Paris; but England, from the wonderful success of the Liverpool and Manchester Rail Road, has already decided on the superiority of this method of communication, assisted by locomotive steam engines, over all others, either by canals or by common roads, for the purposes of general traffic.

The public and private advantages, already derived from this system, have reduced it to a certainty that this mode of construction can be adopted on long roads, with a view to both swiftness and economy. Agriculture, commerce and manufactures will acquire a new impetus, from the communication with the most distant markets, being rendered more rapid and cheaper; the poor man will no longer be obliged to deny himself that which was formerly beyond his means; the rich man will be conveyed with a velocity which formerly all his wealth could not have procured for him, and in a political and military point of view, the mind is lost in its imaginings; nations may collect their armies on their frontiers as if by enchantment.

It is very certain that the advantages of Rail Roads cannot be duly appreciated, until the establishment of long lines shall more fully exhibit them; at present our inferences must be drawn from the single existing instance in Europe, viz: the Liverpool and Manchester Rail Road.

We have no roads in France constructed according to this principle, excepting that from St. Etienne to Lyons and the one from St. Etienne to Andresieux, the functions of which are very limited. It is true that a Rail Road is now being constructed from Paris to Orleans, which will be continued as far as Tours, and another from Paris to Pontoise, which will be continued as far as Havre. These two works which are intended for the transportation of travellers, as well as merchandise and animals, will, it is hoped, turn the public attention to similar enterprises. When they shall be completed, branch Rail Roads will be constructed, giving to the villages in the interior, the same advantages and facilities as to those situated on the main route.

It is not now our intention to inquire if Rail Roads will in future be every where substituted for common roads. We see steam used upon the sea to insure regularity of communication, but nevertheless it has not superseded the use of sails. But should it be found that the substitution of Rail Ways and locomotive engines for the present means of communication, is for the interest of our country, the change will be so gradual as not to injure those private enterprises, which deserve at present a fostering care; and it will be insensible, because that capital will be withdrawn, without any sudden shock, and reinvested where calculation and experience shall show the most advantageous investment.

DESCRIPTION

OF THE

RAIL ROAD FROM LIVERPOOL TO MANCHESTER.

Remarks upon the Origin, Construction, and Use of Rail Roads.

The art of constructing Rail Roads, is by no means of recent date. As early as the beginning of the 17th century, a Mr. de Beaumont, deeply interested in the coal mines of Newcastle, upon Tyne, introduced there the use of wooden rails, to facilitate the transportation of the coal to the river; and not only here, but every where that the system more or less perfected was tried, whether in France, England, or Germany, the interest of the section of country was advanced, until the completion of the Rail Road from Liverpool to Manchester.

Independently of the benefit which the commerce of Manchester, and the surrounding towns have enjoyed from the completion of this enterprise, a source of wealth has been opened to Ireland, in giving increased facilities to the exportation of its products.

Our end already acknowledged, is to nationalize similar enterprises in France, from which we will obtain the same results, and especially the important one of opening a communication from the interior to the market, and thus exciting agriculture and manufactures in those places, where the difficulty of transportation now hinders them from developing themselves.

It is to the invention of the locomotive steam engine, that we owe a great part of the advantages derived from Rail Roads: but in order to appreciate better their value, we will go back to the origin of wooden Rail Roads, and examine the different improvements made from time to time, until they have arrived at their present degree of perfection, which is nearly coeval with the invention of the locomotive steam engine.

Different kinds of Rails.

The best kind of wooden Rail was adopted in the year 1765. The road was graded in the usual manner, six feet in width. Pieces of oak wood, varying from four to eight inch in thickness, were placed at every two or three feet. Upon these pieces of wood, forming the supports, were placed lengthwise with the road, other pieces of wood well squared, seven by five inches; (*fig.* 1. *pl.* 1.) these were fastened by tree-nails driven half way into the supports. Great care was taken that the extremities of each piece of wood should rest on a support, and the road was finished by filling up with earth to the level of the supports. This description of road had many inconveniences. The rails, although constructed to support a great weight, became in a short time so injured by the action of the wheels, that they were broken long before they were worn through; it was necessary to renew them very frequently, and as it was essential to preserve the width of the road, they were always fastened in the same place. The frequent perforations of the supports, induced a not less rapid decay, which was also hastened by the action of the horses' hoofs, in the centre of the road, where the supports were uncovered.

These difficulties were in some measure obviated, by placing a second rail (*fig.* 2.) over the first, which might be worn nearly through, without much impairing the strength of the lower one, as it was no longer necessary always to attach the rail at the same point; and the road was completed by filling up with earth to the level of the lower rail, which screened the supports from the action of the horses' feet.

This latter description of Rail was in use for a long period, although the wood, from its flexible nature, especially when penetrated by rain, yielded to the wheels and occasioned a very powerful resistance. Notwithstanding this retarding force, a horse that on an ordinary road could draw 1700 pounds, could, on a well levelled Rail Road, draw 4200 pounds, which was the ordinary weight assigned to him.

When inclinations could not be avoided, or the road curved too abruptly, flat cast iron bars were fastened upon the rails, with common nails, in order to diminish the resistance. This improvement, which was in fact a very important one, as it equalized the traction of the horse, was not generally adopted, on account of the difficulty of fastening the bars; for the nails, from the elasticity of the wood, soon lost their hold and rendered the greatest care and expense necessary to preserve them.

The next step was the substitution of cast iron for wood in the construction of the rails;

an experiment of the kind was made in 1738, which did not succeed, on account of the weight of the cars. This difficulty might have been remedied by apportioning the weight among several small cars attached to one another; but this was never tried, simple as it may appear; the experiment was again tried in 1768, and from that period cast iron rails were used instead of wood. It has been said by some, that they were not used until 1776; be this as it may, they continued in use until 1824; at which epoch they were superseded by rails of wrought iron. *Fig.* 3, shows the form of the cast and wrought iron flat rails. The method of constructing and laying them varied several times. At first they were six feet long, and rested upon sleepers similar to the supports of the wooden rails, and sometimes upon cubical blocks. They were attached to the supports at the extremities and at the intermediate points, by means of nails driven through holes made for the purpose in the rails. A flange was raised upon the exterior side of the rail, for the purpose of keeping the wheel upon the rail. Stone blocks were substituted for those of wood in 1797.

The most approved flat rail, which is still in use in certain parts of England and Germany, is four feet in length and supported by stone blocks, one foot square on the surface and eight inches deep. An incision is made, when under the hands of the manufacturer, at each end of the rail, in such a manner that when the two ends of the rails come together a square hole is formed, through which a square headed bolt is driven into another hole made for the purpose in the block to about half its thickness, and the two ends are fastened at the same time.

The flange scarcely ever exceeds three inches in height, which is sufficient to maintain the position of the wheel, and is reduced as much as possible to diminish the friction. The part upon which the wheel rests is about four inches wide and one inch thick. On the lower side of the rail is another projection, calculated to give equal strength to the rail at all points, and for this purpose large in the centre, and tapering towards the extremities in a semi-elliptical form. (*fig*. 4.)

It is necessary at this place to observe, that the cars were maintained upon the wooden Rail Roads and iron rails, cast without flanges, by means of a flange upon the wheels, and t in adopting the rails with an exterior flange, (which is called a tram road,) the flanges on the wheels were of course dispensed with; but we shall see soon that they again came into use, upon the invention of the rail called the *edge rail.*

We must recur to the period of the introduction of the cast iron flat rail, for the invention of the edge rail, which is now adopted on all roads of importance.

The first edge rails were of cast iron, and consisted of a bar of iron 3 or 4 feet long, and from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch thick, increasing on the upper side to 2 or $2\frac{1}{2}$ inches to receive the wheel. According to the best pattern now in use, (*fig.* 5.) the width of the top surface is preserved for a short distance below, and then gradually tapers off to a width of $\frac{1}{2}$ an inch, and at the bottom bulges out into divers shapes. The depth varies in proportion to the distance between the blocks. Thus constructed it is equally strong throughout, and presents an equal resistance to the wheel.

The chair, (*fig.* 6.) which receives and preserves the situation of the rail, is of cast iron. Its face is flat, about 4 by 8 inches, and from $\frac{7}{12}$ to $\frac{3}{4}$ of an inch in thickness. It is attached horizontally to the block by means of two holes at the ends, corresponding to two similar holes in the block. In these are driven two pegs of wood, and into these are driven two bolts, passing through the holes of the chair. Two projecting pieces of a width greater than the thickness of the rail, and similarly shaped, receive it, and it is solidly fastened by forcing a wedge into a notch made for that purpose in the chair.

Numerous forms for the chair, and many different methods of fastening them to the blocks have been tried. The one above mentioned, appears to be the most suitable, on account of the ease with which a damaged rail can be replaced or a block readjusted.

The ends of the rails which should always meet upon the chairs, are sometimes notched as represented in *Fig.* 5, but upon the Liverpool road they are square.

The general dimensions of the stone blocks are two feet square on the surface, by one foot in depth, and are solidly bedded in the earth, to prevent their being frequently displaced. By taking care to prevent water from puddling around them, they seldom require adjustment.

It is only recently that the wrought iron rails have been substituted for the cast, although a trial was made of them in 1808, in Cumberland, and their superiority was then evident.

The rails have undergone many modifications, resulting from the employment of this material. One of the most important has been that of extending their length to 12 and 15 feet, to avoid frequent joints; the blocks however are still 3 feet apart. The semi-elliptical projection has been preserved, and it appears certain that the wrought iron rails, will be alone employed upon roads of importance, and for the following reasons: Because that with one half of the material, they can be manufactured of the same size; and that the price of wrought iron is not double that of cast; because its tenacity prevents it from breaking like the cast iron from the effect of great velocity or any sudden shock; because that the rails can be made of a much greater length than those of cast iron, thereby diminishing the jolts which the joints inevitably produce; and finally because the particles adhere uniformly, whilst those of the cast iron adhering only with uniformity on the surface, it results that when the rails begin to be worn by the action of the wheels, their decay proceeds rapidly, whilst the wrought iron rails wear away uniformly.

Moreover, the wrought iron rails weigh 38 pounds to the yard, whilst the cast iron rail weighs 84 pounds to the yard, without possessing the same strength.

We have examined for a sufficient length of time the different kinds of rails, to give a satisfactory idea of them; we will now turn our attention to double and simple Rail Roads, or more properly Rail Roads with single and double tracks.

Construction of Rail Ways with a single or double track.

Single tracks are only used for local purposes, or when the locality will not permit the road to be of the width necessary for two tracks. In case of a road with a single track, turns-out and passing places are constructed in order to permit the passage of cars, travelling in opposite directions. These turns-out are also very useful in roads with double tracks, in order to permit a swiftly travelling car to pass one travelling with less velocity. These are arranged in different modes.

Fig. 7, represents a road with a double with passing-places from one track to the other. Let us suppose a train of cars loaded with heavy goods, and another and lighter train overtaking it upon the same track A A. The first can take the direction *a b*, to pass into the track B B, and permit the train in the rear to continue its rapid pace; arrived at *c d*, it regains the direction A A. The case is the same with two trains meeting at a passing-place. Upon a single track, suppose for instance A A, one of the trains would turn out on *a b* and *c d*.

Methods of turning the Cars from one track to the other.

Divers means are employed to turn a car from one track to another. Suppose *a b* (*fig.* 8.) to be a short rail turning upon a pivot *c*, and *d e* to be a similar rail, which we will call a tongue-piece (*languette*). If these tongue-pieces are in the position shown in the figure, it is evident that they will have no tendency to change the direction of the car from the track *ffff*; but by pushing the tongue-piece *a b* against the rail, and drawing *d e* into the position shown by the dotted lines, it is evident that the flanges of the wheels will direct the car from *f f* to *g g*.

Fig. 9 shows the form of a cast iron rail, called the $\bowtie$ rail, which is placed at the crossing place of four rails, of which two end at *a* and two at *b* and *c*. The projecting pieces *e e* and *f f* prevent the wheels from quitting their direction, at that point where the necessary interruption to the rail prevents the flange from acting against it.

Fig. 10 shows a kind of turn-out for a single track which dispenses with the use of moveable pieces, and also with the employment of a man to regulate them. The cars having always a tendency to move in a direct line, because their axes are fixed and parallel, pass from A to *c* and from A to *b* without turning; those coming from the direction A *d*, rejoin A by *b*, in the same manner that those coming from A *c*, rejoin the other line by *c d;* but this method is exposed to the inconvenience of turning the cars unnecessarily; but on the other hand the moveable rails have that of exposing the cars to the consequences which may result from any negligence on the part of the keeper of the turn-out. Besides this the moveable and $\bowtie$ rails always occasion a jolt at the moment of crossing. This may readily be imagined from the fact, that the moveable rail *a b*, (*fig*. 8.) generally less worn, from being less used than the main track, remains much higher in the same manner that the point *a* (*fig.* 9.) of the ⋈ rail, receiving the weight of the carriages travelling on both tracks, becomes worn very rapidly; and it results that cars arriving at either of these points, experience a jolt from the rapid passage on an uneven surface.

Mr. Wood has been the first to remedy the double inconvenience of turning a train unnecessarily from its direction and of jolts, which are highly injurious to carriages. He practises the following method, (*fig.* 11.)

a b c d is the main track at one of the crossing places, and *e f g h* the same line at another point; *l m h p* and *n k o c* being transverse rails, *i k*, *r d*, are two tongue-pieces, playing freely upon their pivots *i* and *d*, and resting upon iron plates at *k* and *p*. These two tongue-pieces are joined together by a chain at *r k*, and another chain fastened at *r*, passes over a pulley by the side of the road, and sustains a weight intended to bring back the tongue-pieces into the position shown in the figure, when they are moved by the cars. The same tongue-pieces are placed on the corresponding line; and are joined by a bar of iron *l s*. The cars coming from the direction *a b c d* experience no obstacle, for when they are well fitted together the rails present none. The car arriving at *e f g h* the flange of the wheel acts against the rail *e f*, and pushes the moveable rails *s* and *l*, into the proper position, without the least shock. A returning car is turned into the crossing track by the rail *l m*, whilst an opening is left by the position of the rail *s g*; it continues by *o c n k*, and to regain the main track, the wheel acting against *o c*, pushes the moveable rails *i k*, *r d*, into their proper position. It may be remarked that *s l*, exhibits a bar, and *r k*, a chain. The reason of this is, that a car coming from *a*, in the direction of *f*, pushes the tongue *s*, to its place, from the effect of the flange of the wheel acting against *e f*. Consequently it is the tongue *g s*, which acts upon *m l*, and draws it to its position; but not so on the corresponding side; for there, the flange of the advancing wheel pushes the tongue *k i*; but before it reaches the opposite rail, the flange of the opposite wheel begins to open for itself a passage, by pushing out the tongue *r d*, and a bar would therefore be instantly broken. A chain is therefore used, which alcars, supported on wheels of equal dimensions.

For a long time the wheels were made of wood, either of a single piece or of many pieces joined together by wooden tree-nails, and fastened by iron S's, clamped over the joints. The axle was made of wrought iron, solidly fixed in the centre of the wheels and turned with them. On one side, and when necessary, on both sides of the car, was a lever intended to press upon the wheels, and to moderate their speed; *a b*, (*fig.* 13, *pl.* 2.) exhibits the form of this lever termed a *brake;* it is fixed upon the bottom of the car, by an iron pin *d*, at *c c* are attached two pieces of wood, which by pressing upon the lever *b*, act against the wheels.

It is not easy to determine at what period the cast iron wheel was introduced; they were in use however, as early as 1754. In 1765 also, at the coal mines near Newcastle, they used two wooden wheels, and two of cast iron. It was with great difficulty that they decided to abandon the former, which were used on account of the brake, because at first, from want of care in cooling the metal, the castings were very brittle. A more thorough knowledge of its manufacture and properties have since caused them to be generally adopted.

The cast iron wheels for flat rails are generally cast in a single piece, with fellies from two to three inches wide; the axle is fitted to the nave, and turns in the frame of the car; sometimes the wheels are cut out, to diminish the weight, or are made with spokes like common wheels.

Fig. 14, gives an idea of the wheel for the edge rail; *f* is the nave, about seven inches wide, pierced with a square hole *d*, to receive the axle. The felly *c*, nearly four inches in width, is furnished with its flange *b;* it is generally slightly conical towards *b*, in order by this increase in diameter to prevent the wheel in turning, from touching the rail with its flange; this tends rather to throw the car on the other rail; and makes it necessary to use caution in balancing properly the load.

The cast iron wheel gave place to a serious objection; the rails, especially the narrow ones, produced around the wheel a jagged groove which caused considerable friction, and by lateral pressure, fractures constantly occurred the rails were likewise injured by the friction of the uneven surface. The width face of the rails was increased, but this caused a great augmentation of expense.

This objection was entirely overcome, some years ago, by tempering the periphery of the wheel, which is done by running the metal, which forms the superior surface, over a piece of cylindrical iron. The rapid abstraction of the heat, caused by the coolness of the iron, gives to the casting such a degree of hardness, that the file can produce no impression, and this hardness prevents the rail from indenting the wheel as it formerly did, causing large annual expenditures, where as now they need but few repairs. Some may be seen which after eight years service, will be fit for use still many years.

A perfect temper was not given to the felly of the wheel at the first trial. The rapidity with which the metal cooled prevented the parts of the wheel from contracting uniformly; the spokes were broken by the first sudden shock. Messrs. Losh and Stephenson invented the wheel (*fig.* 14). The spokes were of malleable iron and dovetailed at the extremities; being placed into the mould, the metal was cast, and when it was joined at the nave and fellies, and cooled, it was found that the cast and wrought iron were so well joined, that the spokes were perfectly solid. The wheel was at first cast with only six spokes: it was found by experience that a greater number was necessary; and they were made of the form of a serpent, in order that they might contract and expand more readily during the cooling of the metal.

It was then supposed that the manner of constructing wheels was perfect; but it was soon found that the extreme rapidity with which they moved, caused fractures, not only on account of the brittle nature of the material, but because the friction of the fellies upon the spokes, heated and expanded them. They were then constructed with a tire (*bande*) of wrought iron. But the last perfecting improvement, and to which we may predict a long duration, has been made by Mr. Stephenson, by fabricating the wheels totally of iron; they have as many fellies as spokes, shaped in the serpent form, and each felly and spoke is wrought from the same piece of iron. The spokes a dovetailed at the nave end; the other end, the place where the felly begins, is curved such a manner as to join the corre felly, and the whole is consolidated screw bolts. The surface of the fellies is tempered as before.

The axles of the coal cars are squared at the ends, to adapt them to the square hole *d*, of the nave. Their size depends necessarily upon the diameter of the wheels, and the weight to be sustained. For coal cars, the diameter of the axles is from two and a half inches to three and three quarters inches with wheels of three feet diameter; the weight of the car and its load may exceed three tons.

Upon the lines of public roads, the shape of the cars is regulated by the kind of goods to be transported; those of great bulk demanding cars of appropriate dimensions. The coal car form, of which we have spoken, larger at the top than at the bottom, is suitable when the load is to be deposited at the end of the Rail Way; but when the goods are to be transported to a distance from the line of the Rail Way, the body of the car should be constructed in such a manner as to be moved upon wheels suitable for the common roads. *Fig.* 15, is a model in profile of a car of this description, of which the box supported upon rails, is transported at will upon a car arranged for that purpose.

After the examination of Rail Roads and of the cars used upon them, we come naturally to the consideration of the power necessary to put them in motion.

Moving Powers.

Horses were at first the only moving powers; and so long as the rails were constructed simply of wood, no more was demanded from them, than to draw a weight of from two to two and a half tons.

After the invention of wooden rails, furnished with iron plates, the load was increased to fifty three hundred weight, exclusive of the weight of the car. This weight was doubled on the introduction of rails and wheels of iron; and it was at this period that the excess of gravity, in a loaded car descending an inclined plane, first suggested the idea of employing this power to draw up the empty cars; this was called the reciprocal power. At a later period, stationary steam engines were used to draw up the carriages to the summit of the inclined planes, by means of ropes; and finally a locomotive power was given to steam engines; but in order that it should produce very beneficial results, it is necessary that the Rail Road should nearly as possible horizontal. Under particular circumstances, horses, and on steep planes, stationary engines, are advantageously substituted for locomotive engines.

The force of a horse drawing a car, is divided into two parts: that of his body, which he throws forward upon his collar, to overcome the resistance of the weight, and the muscular force of his limbs, which he uses to assist his first effort and to get forward. The exertion of his power has then two effects; that produced upon the weight, and that which serves to carry him in advance. It has not been finally settled what proportion exists between the power which he should uniformly display upon a road and his own weight. This power has been set down at 200 pounds at the rate of two and a half miles per hour, for a space of eight hours; others reduce it to 150 pounds. Assuming this latter proportion, it is easy to see that it can be considerably increased, but at the expense of speed. A horse of a mean height, weighs about 1100 pounds. Taking this as granted, let us divide his muscular power into eight parts, of which seven are necessary to his progressive motion and one to act upon the weight. Now, if the road be inclined until the force of gravity shall be equal to the power acting upon the weight, it will be stationary; it is necessary then to take into consideration the inequalities of the road.

These calculations, confirmed by experience, have furnished the following results:

A strong horse can conquor a resistance of from 240 to 250 pounds, but for a short distance.

So long as the resistance in ascending does not exceed 180 pounds, he can draw upon a road inclined at the rate of

1 foot in 448,	12 tons
1 do. in 400,	11.53
——— 350,	10.96
——— 300,	10.30
——— 250,	9.48
——— 200,	8.50
——— 150,	7.21
——— 100,	5.55

On the Stockton and Darlington Rail Road, there are places where the descent is sufficiently great to enable a car to descend by its own weight: nevertheless they make use of horses; but when the force of gravity overcomes the resistance of the wheels, they mount the horses on a platform upon a car prepared for this purpose; they resume their service as soon as the employment of their strength becomes again necessary. It is to be remarked that they are soon reconciled to their temporary stable, into which they become eager to enter. When the features of a country will not allow a route to be level, it is divided into many stages, separated by short inclined planes, upon which another power is used, viz., that of gravity.

This power cannot be employed except upon a road where much the greatest proportion of the traffic is in the same direction, and when upon the planes which occur in this direction, this greater mass shall be sufficient to conquer the force of gravity of the cars coming in the opposite direction.

The object of inclined planes being to facilitate the descending movement of a weight, in a given time, with the least possible expense of power, the road should be calculated not only to give an advantage to the descending over the ascending trade, but that this advantage should be extended, so that the descent of the one should assist in the elevation of the other, with the necessary swiftness.

If the plane is too steep, the ropes passing over the pullies as well as the cars are exposed to violent shocks, which injures them and increases the expense. If it is not sufficient, the resistance cannot be overcome; but in the latter case, a greater number of cars can be used with the descending train. Therefore the suitable inclination cannot be determined, before having well settled the friction, the force of gravity, the weight of ropes, &c.

We give (*Fig.* 16. *Pl.* 1.) the plan of a wheel used to draw up a weight from the effect of one descending. It is generally of cast iron, with six spokes, and with a periphery sufficiently grooved to receive the rope which turns around it. It is placed at the summit of the plane, in a square hole of masonry, almost on a level with the ground, and between two wooden frames, of which the upper one is represented by *a b c d*, and braced by cross bars *e e*. The axis turns freely in its two supports; of which the upper is shown at *g*. A horizontal place is always contrived at the top and bottom of the plane of at least sixty or eighty feet in length, to receive the cars and to prepare them for the ascent or descent, as the case may be. The little cast iron rollers *ss*, *ss*, *ss*, are placed at a distance from one another of about twenty-four or thirty feet, in the direction of the rope, to prevent it from rubbing on the ground, and thereby diminishing the friction. Their width of from three to four inches is found quite sufficient; and they have a diameter of from eleven to twelve inches, with a flange on each side to prevent the rope from quitting it. Sometimes these rollers are supported by pieces of wood, and sometimes by supports of cast iron, placed in the middle of the road. The axes are of wrought iron, 3–4 of an inch in diameter, when they are placed on upright supports. Those represented on the figure appear greater than we have described them, as the scale has been increased in order to represent them more distinctly. Their weight varies from twenty-one to twenty-five pounds. Some are made concave on the surface, whose weight, from the diminution of the quantity of metal, does not exceed twenty pounds. The ground will not always allow the descent to be uniform, occasioning frequent curves in the line; but a straight place should always be constructed at the bottom of the plane, to receive the cars. We have shown the wheel at the summit of the plane uncovered in order to describe it: it is, however, always concealed and the rails, shown by dotted lines, pass over it.

Let us suppose that *a a*, represent the extremity of the platform; *three* rails *r r r* are placed from this point, almost to the middle of the descent, in such a manner that both the ascending and descending cars should bear upon the centre and one of the exterior rails. Near the point where the carriages should meet, the three rails divide into four, for a certain distance, as from *a a* to *b b*, (in order that the cars may pass each other,) and then again come together, forming a track with three rails, or in many instances with only two, as at *c c*. We see by the plane that the loaded cars pass indifferently upon the lines *d d*, and *e e*; for if a carriage commences its descent at *d*, with one end of a rope attached to it, and the other end to the empty car to be drawn up from the point *e*, at the bottom of the plane, when the car shall arrive at the bar *d*, it is evident that the empty car will have gained the point *e*, at the top of the plane.

When the plane is too much inclined in any place, the velocity can be retarded by the brake of which we have already spoken; if it should happen that the force of gravity, notwithstanding the force necessary to raise the ascending car should overcome the resistance of the ropes and of the brake, the car would become unmanageable; the rope would slip upon the wheel, and the most disastrous consequences ensue. The slope of the plane therefore should be so arranged, that though giving an excess of the force of gravity at first, it should be reduced in proportion to the increase of velocity, gained by the cars at every moment of their progress, in order, as nearly as possible, to render the descent uniform. The cycloidal form appears to be the most suitable for a plane, in order to obtain this result. Many other plans for employing the force of gravity have been tried; but except in a very few instances, and for particular purposes, none have succeeded as well as the above, where the friction of the ropes has been reduced as much as possible.

Another power made use of, in place of the horse, whose power is very limited on steep ascents, and of gravity which only acts on descents, and in fine on all roads, let their inclination be what it may, is the stationary steam engine. It was in 1808 that the first was constructed, at a place called Birtley Fell, in Durham county.

The following are the different kinds of planes upon which it acts, viz:

Upon planes where the quantity of merchandise to descend is greater than that to ascend. If the gravity of the cars is sufficient for them to draw down a rope with them, this rope is fastened to the cars which the engine is to draw up. A single line may then be established; but if two be constructed, they can be made with three rails, separating into four at the crossing place. In this case, if the descending car has an excess of gravity, this force may be used to assist the engine in drawing up the ascending cars. If the number of descending cars is less than of those ascending, the latter will not have a sufficient number of ropes; and in this case ropes are either sent down attached to heavy cars, or else a sufficient degree of power is given to the engine to raise them altogether. Moreover, the ropes sent down by weights cause a great expense, which it is as well to avoid.

Where the inclination is not sufficient to allow the cars to draw a rope with them, let us imagine always two lines with three rails, dividing into four; at the bottom of the plane is placed a wheel similar to that formerly described. Each car has a rope fastened to the machine, and another rope passes round the wheel, and affixed to the ascending car. Thus the descending car, if the slope is not sufficient to cause it to descend by its own gravity, is aided by the ascending car, upon which the engine acts. And this means may be employed under any circumstances of locality, and even for great distances by increasing the number of engines.

When an ascent is to be overcome, and immediately on the opposite side, there is a sufficient degree of inclination for a car to descend of its own weight and draw with it a rope, the engine is established at the summit. If a single track of rails be established, the ascending car is drawn up by a drum (*treuil*,) over which the rope passes; arrived at the summit, it passes under the drum and descends the opposite plane, unrolling the rope, which is attached at the bottom of the plane to the ascending car. A single track may be constructed on one side and a double track on the other, and if the business requires it, two tracks and two drums are made use of, and if the inclination is not sufficient for the spontaneous descent of cars drawing a rope, they are assisted by the wheel formerly described.

Finally, to continue for a distance this mode of transportation by engines stationed at intervals, a car is brought from one machine to another by means of a rope, which is taken back by the returning car; with two tracks there is no interruption but that of changing the ropes.

Mr. Stephenson has adopted the endless rope, for passing the great Liverpool tunnel. A double track is constructed, for the whole distance. At the foot of the plane B, is a wheel, around which the rope *e f*, passes. At the summit of the plane is another horizontal wheel A, moved by two engines on the sides of the railway; there are two grooves on the periphery to receive the rope, which passes at first from *e* into one groove, crosses into the wheel *a*, passes over this and turns around the last wheel *b*, crosses again to *a*, turns round the other groove of A and redescends by *f* to join B. By passing twice round the circumference of A, the rope creates a degree of friction sufficient to draw the cars to the summit of the plane. In order to give it an additional pressure, a heavy weight is attached to the wheel *b*, by a cord passing over a vertical pulley *c*. This weight descends freely into a cavity prepared for the purpose, allowing the rope to lengthen or contract according to the variations of the atmosphere. As the ascending cars occupy one track, and the descending another, the engine never changes its motion.

Having now described the means of transportation by stationary engines, under all circumstances, we come to the consideration of locomotive steam engines, the velocity of which requires that the roads should be as level as possible, in order not to be retarded.

Messrs. Trevithick and Vivian were the first persons who constructed an engine only acting by the expansive force of steam, for which a patent was obtained in March 1802. Their intention at first was to apply them to common roads, but the strong opposition which they encountered, induced them to direct their attention to the application of locomotive steam engines to rail roads. Two years afterwards an engine was tried by Mr. Trevithick, which travelled at the rate of five miles an hour, with a load of ten tons on a level road.

The greatest obstacle to the use of this motive power, was the supposed want of adhesion of the wheels to the rails, for the purpose of producing a progressive motion. Messrs. Trivithick and Vivian, to remedy this inconvenience, advised that the wheels should be made rough in the circumference by headed nails, &c. Mr. Blenkinsop obtained a patent for the application of a rail with cogs, to be laid the whole length of the route. By means of this rail, into which a cog wheel fitted, an engine could ascend an inclined plane. Engines made upon this principle, are still employed upon the Middleton Rail Road, for the transportation of coal to Leeds. Mr. Blackett first proved by his experiments, that the adhesion of the wheels upon the flat rails, (which present a greater surface, and consequently cause more friction than the edge rail,) was sufficient to give motion on a level or slightly ascending Rail Way.

Many experiments were made, to construct an engine resting on four wheels, instead of six or eight; and which should manœuvre without cog-rails, or any other exterior contrivance, and whose motion should be communicated by the adhesion of the surface of the wheels to that of the rails. The cause of this action is very evident; the power of the steam in the cylinders is used to turn the wheels, which press upon the rails with a force equal to the weight of the engine, divded by the number of wheels. Thus, if there are four wheels, the pressure of each wheel is equal to the fourth been made for the ropes, used under circumstances previously described. In general, the friction of the ropes, no matter upon what plane used, is established by taking the weight of all the apparatus, inclined wheels, pulley and ropes, the pressure of the latter upon the wheels, and the extra pressure, occasioned by curves in the line. The friction amounts to one third of this weight, when drums or axles are not used.

We have seen (*page* 33,) the strength or power of a horse established by many experiments. Upon the plane of Killingworth, where the force of gravity is used for a moving power and with a wheel around which a rope winds, attached to the end of a descending train at one extremity, and to the ascending train at the other, the following experiment has been made:

The length of the plane was two thousand one hundred and forty-five feet, the descent fifty-seven feet six inches; five loaded cars, weighing each eight thousand six hundred and seventy-four pounds, and altogether forty-three thousand, three hundred and seventy pounds, descended by the force of gravity, drawing up six empty cars, weighing each, two thousand, eight hundred pounds, and together sixteen thousand eight hundred pounds, in the space of three minutes and twenty seconds; the rails were arranged as shown in the figure, and the rollers were seventy-three in number.

The following experiments relate to stationary high pressure engines.

Upon a plane, two thousand eight hundred and ninety-two feet in length, and descending fifty-seven feet eight inches, eight cars weighing eight thousand six hundred and twenty-four pounds, altogether sixty-five thousand nine hundred and ninety-two pounds in weight, were drawn to the summit of the plane, in six minutes and thirty seconds.

The cylinder measured sixteen inches; the pressure of the steam in the boiler was fifty pounds to the inch. The piston made four hundred strokes of $5\frac{1}{2}$ feet each$=$2200 feet. The pressure of the steam upon the piston, calculated at ten thousand and fifty pounds, and multiplied by 2200$=$22,110,000 pounds, for the power of the engine for one foot.

The total resistance to overcome, was two thousand one hundred and thirty pounds for two thousand eight hundred and ninety-two feet; which multiplied together, gives 6,159,960, the resistance for one foot.

Compare the effect produced with the power of the engine, and we find for the result that the effective power of the engine is twenty-seven per cent. of the pressure upon the piston.

Velocity of piston 333 feet, per minute.

Velocity of weight 445 feet per minute, or five miles an hour.

Assuming thirty three thousand pounds, as the power of a horse per foot per minute: let us suppose a train of eight cars, loaded with nine thousand four hundred and eight pounds each, to be raised upon a plane of sixty feet elevation in three miles of length, in five minutes, the resistance calculated at two thousand two hundred and ninety-four pounds, will equal one million three hundred and seventy thousand four hundred pounds, raised one foot per minute, consequently $\frac{1370400}{33000}$ is equal to the power of forty one and a half horses.

To compare with the examples above quoted, we give a table of the power of a locomotive engine, upon planes of different inclinations, its own weight being six tons.

The second column of the following table, shows the weight, when only two of the wheels are put in motion, and that $\frac{3}{5}$ of the load bears upon these two wheels. The adhesion in this

Engine of 10 horse power, by Walker & Rastrick.	Liverpool & Manchester.	33	16½	10½	60	18	9	10½	37½	13	6½	10½	30	27½	13¾	10½	51½	14½	7½	10½	39½	7½	3¾	6½	17½
Engine with 4 wheels & cog-rail, by M. Blenkinsop.	Middleton Coal Mines, near Leeds.	22½	11	6¼	39½	12½	6¼	6¼	23¾	9	4½	6½	19¾	19¼	9½	6¼	35	10¼	5¼	6¼	21¾	7½	3¾	6½	17½

case is calculated at $\frac{1}{15}$ of the weight. The third column shows the weight raised; the adhesion being $\frac{1}{20}$ and the cylinders acting upon four wheels; the diameter of the wheels being four feet.

The absolute power of many locomotive engines, reduced to the same velocity of five, eight and ten miles per hour, acting upon cars constructed for the transportation of goods, is here shown. The effect produced is much less in winter than in summer; but the variations of the atmosphere sufficiently explain this difference.

The effects given above, necessarily vary with the weight of the engine and its burden; in every case, if the total resistance produced either by the force of gravity at a certain elevation of the plane, or by the friction, or by both these causes combined, does not exceed the fifteenth or twentieth part of the weight of the machine, the adhesion of the wheels will be sufficient to cause a progressive motion without sliding, at any temperature. Superior effects may even be obtained in fine weather, and when the rails are in a perfect condition; for those stated in the preceding table, were obtained when the rails were in their worst condition, and when the weather was most unfavorable for adhesion; but on account of the injury which the sliding causes both to the wheels and rails, it is better to have the load below than above these limits.

We give, (*plate* 2,) the plan and profile of the most perfect locomotive engine, constructed by Messrs. Stephenson and Co.

The boiler is cylindrical, seven feet long, and encloses eighty-two copper pipes, one inch and a half in diameter, communicating with the fire-place, and through which the heated air passes. In the rear, is divided off a chamber which contains the fire-place, and which is cylindrical at its summit like the boiler; it surrounds it at this part, and communicates with it, to leave a passage to the water and steam. To the square base of this chamber is fixed the square box of the fire-place, three feet eight inches wide, two feet long, and two feet ten inches and three quarters high; a space is left around it, two inches wide, in which the water circulates, which thus surrounds the fire. This box is only half the height of the boiler; the space above is occupied by water and steam.

The grate which supports the combustible in the fire-place, has a superficies of seven feet, four inches; the external air is introduced from beneath. By the position of the box of the fire-place, it presents a surface of nearly nineteen feet to the water which it heats. On the other hand, the flame and the warm air, which pass through the tubes from the fire-place, exercise their united influence upon the water, and over a total surface of two hundred and twenty-five feet. A chamber is constructed in the fore part of the engine similar to that in the rear, and from the top of this the chimney is raised. The bottom of it contains a certain quantity of water, into which a discharging tube empties, and deposits the cinders produced by the horizontal tubes, upon a crossplate of iron, placed over it like venitian blinds. Below this chamber are the two cylinders represented, in (*fig.* 19,) and also by the dotted lines, *a b c d*, (*fig.* 18.) The axis of the great wheels, being with double cranks, at right angles to one another, each one of them is put in motion by *a* an arm *f*, serving as a prolongation to the piston-rod of the cylinder, which the guides *e*, maintain in a horizontal position; one of these cranks is shown by the dotted lines *g h;* both acting upon the axis, give a rotary movement to the large wheels, which support in equal proportion the weight of the engine. The effects of accidental shocks, are obviated by the use of springs, *s s;* those of the large wheels are attached to the supports of the axis, but the supports of the axis of the small wheels, have their springs below. The steam generated, passes into the cylinders by means of ordinary valves, which are put in motion by the eccentricity of the axis of the great wheels. This movement is communicated to them by the rods, which act upon the arms, *i i n n*, of the cross piece *o o.* To put the engine in motion, or to moderate its speed, they make use of handles adapted to the square pieces 1 1, and 2 2, (*fig.* 18,) by which the rods 3 3, are moved, communicating with the axis, *o o*, by which the valves are opened. Two safety valves, visible upon the engine serve for the escape of the steam, when it is desired to relax or stay its progress; one of these is out of the control of the Engineer, and indeed is often closed. The height of the water in the boiler is shown by a glass tube. Finally the engine is steadied upon the frame of the carriage by the square iron braces, 4 4 4 4, (*fig.* 18,) and also shown by the dotted lines, (*fig.* 19.)

The tender containing water and fuel, is attached to the rear of the engine near the fire-place; and by means of a pump, with a trough, moved by the engine, the boiler is replenished at will.

We will here conclude the observations, which were thought necessary, previous to giving a description of the road from Liverpool to Manchester, to give an idea of Rail Roads from their origin. It will however be sufficient, it is hoped, to excite an interest in the examination of the line, which from the place called Wapping, near the docks or basins at Liverpool, extends to the street called Water street at Manchester.

It will not perhaps be out of place, to give here some details relative to the first of these towns, which this new communication with the interior, will soon raise to the rank of one of the most important cities of Europe.

Liverpool.

Liverpool is situated upon the east bank of the river Mersey, in the county of Lancaster, and near the point where the river empties into the Irish Sea. It is about two hundred and four miles from London, in latitude 32 deg. 22 min. 30 sec. north, and in longitude west from Greenwich 2 deg. 57 min. Its length from north to south is about two miles and a half; its greatest width, one mile and a third, and its circumference nearly six miles.

At the present time, Liverpool is the second city in importance in Great Britain; after London, it is the most populous, the richest and the most commercial city in the kingdom; although in 1565, it was only a little hamlet, containing a hundred and thirty-eight inhabitants; and even in the year 1700, it only contained four thousand two hundred and forty. We give below a table showing the increase of inhabitants until the year 1821.

In the	year	1565,	138	inhabitants.
"	"	1700,	4.240	"
"	"	1720,	10.000	"
"	"	1730,	12.000	"
"	"	1740,	18.000	"
"	"	1773,	34.407	"
"	"	1790,	55.732	"
"	"	1801,	77.653	"
"	"	1811,	94.376	"
"	"	1821,	118.972	"

The census of the last years does not include the population of the suburbs, which amounted in the year 1821 to 22,515 souls, nor the sailors belonging to the port, the number of which at the same time was 10,000! It has been calculated since the last census, that the increase in the city and suburbs amounted to 37,500, which added to the number of sailors, on board of vessels, would make the population at the present time, amount to more than 180,000.

It is only lately that its commercial importance has been acquired. So little were foreign products known there in 1784, that eight bales of cotton were seized by the Custom House from an American vessel, as not coming from America as was stated. In 1824, the duties were paid upon four hundred and nine thousand six hundred and seventy bales, and in 1829, upon six hundred and forty thousand nine hundred and ninety eight bales of these same cottons.

In the year 1760, the number of vessels in the docks, only amounted to two thousand five hundred and sixty; in 1824, to ten thousand; and in 1829, to eleven thousand, three hundred and eighty-three.

Finally, the dock duties, which in 1734 only amounted to 810 pounds sterling, exceeded, in 1830, the sum of 151,239 pounds sterling.

The city, the situation of which on a hill, is very agreeable, contains many beautiful public buildings; such as the Exchange, the new Custom House, a Botanical garden, a Library, a Theatre, and an Asylum for the Insane. In Great Howard street, one cannot observe without interest the prison built under the direction of Howard the Philanthropist, as a receptacle for French prisoners. From the top of the City Hotel, there is a view of Liverpool, and of the neighbouring county of Chester, (from which it is separated by the river Mersey,) and of the numerous country seats in the vicinity.

There are two cemeteries at Liverpool, separate from the churches, which is very rare in England, but still surrounded by houses. The general north western cemetery, also called the Necropolis, is twenty-four thousand square yards in extent, intersected by winding walks, and ornamented with bowers. There is a chapel here for the use of those families, who do not wish to make use of the ministry of the clergyman, who is attached to this resting-place of the dead. The other cemetery, called, "the cemetery of St. John," in a north-easterly direction, is only 500 yards long and ninety yards wide, but its appearance is much more curious;

as it was formerly a stone quarry. On one side is an elevation almost perpendicular, of fifty-two feet in height; and separate vaults for families have been cut out of the solid rock. The level portion has been laid out in bowers, and gravelled walks. At the entrance is a church of Grecian architecture, with an elegantly constructed habitation for the pastor, and a little further to the south, the lodge for the porter. But the greatest ornament of Liverpool, is undoubtedly the docks or basins, which are eight in number and capable of receiving a thousand vessels; two others are now being constructed, one called the new dock, and the other the Brunswick dock. The Duke's dock, belonging to the family of the Duke of Bridgewater, is in the centre of the other docks, and prevents them from communicating together.

The distance from Liverpool to Manchester by the common road, is thirty-four miles, and thirty-two by the Rail Road.

JOURNEY

OF EXAMINATION,

FROM LIVERPOOL TO MANCHESTER.

The point at which the Rail Road departs from Liverpool is called, as we have previously stated, Wapping, at a short distance from the Queen's dock. Two branches are there constructed, one giving upon the port, and the other into a neighboring street, called Crosbie street. Above the deep cut, excavated to a depth of twenty-two feet, forty-six feet wide, and one hundred feet long, and with four tracks of rails, are the depots of the Company, intended to receive the goods, which might be injured by exposure to the air; these extend over the whole of this length. Light cast iron pillars, erected between the tracks of the rails, support the beams of the floor, at a sufficient height, to leave a passage for the cars, which are loaded or unloaded through trap doors, constructed in the floor of the magazine; which are approached by placing rails communicating with the main track, by moveable rails, turning upon revolving circles of wood. On emerging from beneath the magazines, an uncovered abyss presents itself, built up with stone walls on both sides; in the angle on the left hand side, is a little building appropriated to offices, and quite near to it is the mouth of a gloomy cavern, built up around the front to a great height, with a brick wall, without any ornament whatever. This is the commencement of

The Great Tunnel.

The stranger who views for the first time this magnificent vault, which to him appears interminable, cannot divest himself of a feeling of wonder. When we consider its length, the dangers and difficulties encountered in its execution, we must regard it as the triumph of genius and perseverance. In former times, before science had endowed man with the powers which appeared to belong to God alone, the very idea of such an undertaking, would have been considered as the height of folly and audacity. Even in the present advanced state of science, the most skilful mind must pause and admire this excavation, at the same time so perfect, and of such extent.

An enormous door, strengthened with iron, is hung at a few steps from the entrance, by pivots at the top and bottom of the Tunnel, in such a manner as to be moved with great facility; and although closing the entrance to the vault, permits the free circulation of air. The tunnel inclines towards the south-east, by an extremely light curve, for about eight hundred feet, extending to the foot of the inclined plane, which is straight, and of a uniform slope of one inch to the foot, and so continues to the end of the summit at *Edge Hill*, which is a distance of five thousand nine hundred and forty feet; the whole distance from Wapping to the end of the tunnel, is more than a mile and a quarter, and rises one hundred and twenty-three feet.

The bottom of the tunnel is covered with dry and smooth sand; the white-washed sides have not that gloomy aspect, which is expected from the appearance of the entrance. The air, freely circulating, does not, in the least impede the respiration; and the atmosphere, fresh and agreeable, is not subject to frequent changes; except during the prevalence of a fog, when the day-light at the ends, and the lights in the interior are not bright as usual. The traveller, advancing into the cavern, remarks from the rumbling sound of the carriages over head, that he is beneath one of the most populous streets of the city; and this is confirmed from time to time by the inscriptions on the walls, such as St. James street, Pitts street, Great George street, &c.; under which the line passes at different depths.

It is difficult to conceive, from the appearance of the tunnel now so finished and neat, the immense quantity of labor employed upon it.

The excavation was commenced simultaneously at many points of the line, as originally located; but the line having been subsequently moved, about twenty feet more to the north, it was necessary to open a passage, to conduct from the shafts to the tunnel. The marks of the openings of these passages may still be seen, although they are now stopped up. The pits were dug through a red rock, and sometimes through earth, of a not very tenacious character, and on that account dangerous. The workmen were guided by the compass, and joined their excavations, with rarely more than one inch of deviation, although some of them were five hundred yards in length. The work consisted of blasting the rock with powder, cutting it unremittingly with a pick-axe, or breaking it by the aid of a hammer and wedge; in getting down carefully the soft freestone and clay, and in propping up the masses suspended above, until they could be supported by the centering of the arch. This perilous work was continued night and day, without intermission, for more than twelve months, before the opening of a passage was completed from one end to the other. The materials extracted from the bowels of the earth, by the openings to the pits were used to raise up the site of several proposed streets, and to fill up the neighbouring hollows. A great number of building stone, and blocks suitable for the Rail Road were also procured from the excavation.

The tunnel is twenty-two feet in width, and sixteen feet high, through its whole length. The sides are perpendicular, five feet in height, from which point the arch springs, being a perfect semi-circle. About two thirds of the excavation is through solid rock; but those parts which do not appear sufficiently solid, or those composed of sand, clay, or other materials of little tenacity, are supported by brick centering. Stone was used at first for this purpose, but as it was found difficult to dress it into arch stones, bricks, eighteen inches by two feet in thickness were substituted, which were found to answer the purpose perfectly, being at the same time, strong and presenting a neat appearance. In excavating through the solid rock, the sides and a portion of the arch were first excavated; the centre answered the purpose of props, and was removed in proportion as the work advanced. In the less tenacious parts, where water frequently occurred, it was necessary to use many more precautions. The most discouraging difficulties were constantly occurring, requiring the greatest skill and perseverance to overcome. The miners, if we can credit the stories told upon the subject, offered, when seen from a distance, and from an obscure point, one of the most interesting coup de œils imaginable. The numerous lights shining in the deep obscurity, like stars in a dark night, their faces shown ever and anon in black profiles, their arms in motion, and if to this picture is joined the frequent explosions and the smell of the powder, we can form a tolerable good idea of some infernal operations in the regions of Pluto.

Large quantities of water interrupted the work at different times; but now, with the exception of a little trickling at one or two parts of the arch, which has been conducted down the sides by a trough of Roman cement, the tunnel is entirely dry, as the exudations run into a gutter, the murmur of whose waters, is heard under ground, by the side of the Rail Way.

The excavation, made to a depth of from five to seventy feet from the exterior surface, would have afforded an opportunity for some interesting observations to the geologist, if, as we have already stated, the sides had not been white-washed, to reflect the light. The changes of the soil, which have been operated in a succession of ages, are frequently visible. Towards the end of the tunnel, where it is only separated by a few feet from the foundations of the houses, the greatest precautions were used; they made use of no powder; and the rock, whenever it occurred, was excavated by the hammer and wedge. Many wells, to the great astonishment of their owners, were cut off in the middle, and one or two houses were shaken by the fall of a part of their foundations, but no serious accident resulted from it, and the upper surface of the ground is now as solid as if no excavation had been made. On very light days, the light at the end of the tunnel at Edge Hill, may be seen from the foot of the inclined plane, that is, for more than a mile. It appears at first like a speck, and gradually increases as the observer advances. It has been found by experiment that on very clear days, it is possible to read a letter at the distance of half a mile from the opening; but to see the tunnel in all its beauty, it must be visited when the gas is lighted. It was on the first day of July, 1829, that this vast work was formally opened by the Directors of the Company, accompanied by the City Authorities. It was lighted by fifty jets, one hundred and fifty feet apart, suspended through the whole length of the arch. The nearest lights to the spectator appear at first, very distant from one another; in the perspective they appear gradually to approach, until the eye becomes dazzled by a line of fire, of all colours, from the purest white to the deepest red. Those parts of the arch and of the sides nearest to the light, are so dazzlingly lighted, that the whole tunnel appears to be composed of a succession of beautiful arches, cut whole, between the parallel walls; the intermediate spaces being buried in comparative darkness

The Directors and the authorities, seated in cars, which descended by the force of gravity from the summit of the inclined plane, travelled with a velocity which would have carried them to Wapping in three minutes, if the speed had not been moderated. Upon emerging from the tunnel, where the gas-lights are now doubled, the traveller arrives at

The Edge Hill Summit.

This excavation, made upon the East side of the Hill, is a large space of a quadrangular form, of about one hundred and fifty feet in length, and with the exception of a superstratum of earth, cut into the solid rock, to a depth of forty feet, the rock which forms three sides is almost perpendicular, and although dressed with the pick-axe alone, presents, owing to its height, a neat appearance. Above the rock, and nearly at two thirds of the whole height from the base, a brick wall has been built, capped with stone. The north and south parts are ornamented with palisades, and the eastern part, with a parapet and battlement. The two eastern corners of the quadrangle are occupied by two buildings for the stationary engines, which draw the cars to the summit of the inclined plane, from the Wapping end, by means of a double set of ropes, passing over rollers, through its whole extent. These buildings have the appearance of two towers, and in the middle has been constructed an arch of great dimensions, so that the whole forms the gate or entrance to the Liverpool station.

On the east side of the quadrangle, and in the centre of the solid rock, is the entrance of the tunnel, previously described. To the north of this is another little tunnel, conducting through the Hill, to the enclosures of the Company, in Crown street. On the other side of the principal tunnel, is another, which is not very long, and has no issue; it is used for work-shops, and was made in order to preserve a symmetrical appearance; the three tunnels present the appearance of a bridge with three arches.

On the west side of the quadrangle, above the angles of the wall, are seen two Grecian columns, built with compartments of brick, and having their pedestals and principal ornaments of stone. These columns, which are beautifully proportioned, and raised to the height of a hundred feet, answer the double end of ornament, and to show the commencement of the open cut. The taste of the builder will be more highly appreciated, when it is known that these ornaments serve a very useful purpose, as they are the chimneys of the stationary engines. The boilers are placed in little tunnels, cut laterally into the rock on the east side. This may be considered as the real starting place of the locomotive engines.

The Little Tunnel

is intended for the transportation of goods from the upper part of the city, which is too distant from the entrance of the great tunnel, and also for the conveyance of passengers; it traverses the hill from east to west, and conducts by a single track of rails to the spacious depots of the Company in Crown street. It may be regarded as a beautiful miniature of the great tunnel; two hundred and ninety-one feet long, fifteen feet wide, and twelve feet high. Proceeding in a direct line from the great summit, just described, it rises towards the west, at the rate of half an inch to the yard, an ascent so very gentle as to be scarcely perceptible. For two thirds of its length from the eastern end, it is cut from the hard rock, with the exception of a few soft and insecure places. Having encountered in the last third part, substances of a very yielding nature, brick was made use of to support the sides and arch. The light can be seen from one end to the other of this tunnel; but as it is dark in the middle, it has been furnished with many gas-lamps, having a very beautiful effect. Over the eastern entrance is constructed, a bridge, for the highway, built of bricks, and stone joined with Roman cement. Upon issuing from this place, the traveller finds himself in the spacious courts of the Company, the rails being prolonged to the extremity of them. One side is appropriated to the reception of coal, for the supply of the upper part of the city; and upon the other is a range of coach houses, containing cars belonging to the road, and opposite to this, is a beautiful building, which contains the offices of the Directors of the cars, and halls for the reception of travellers, who are brought from different parts of the city, gratis, in an omnibus called the *auxilium*. On leaving this point, the cars are abandoned to their own impulse, as far as the Edge Hill summit, where they are attached to the engines. This court, surrounded by high walls, has its entrance into Crown street.

The following are the hours of departure of the passenger cars, and the price of seats:

The passenger cars are of two classes, and depart at different hours.

Those of the 1st class, with six inside places at 5s.—Those of the 1st class, with four inside places, at 7s.

Depart at 7 and 10 o'clock, A. M. and at 2 and 7 o'clock, P. M.

Those of the 2d class, closed with glass, at 5s.—Those of the second class, open, at 3s.

Depart at half an hour after seven, A. M. and at 1 and 5½ o'clock, P. M.

When the road was first opened, both the carriages of the first and second class, took up and set down passengers at any point of the route; but to avoid this inconvenience of too frequent stoppages, the carriages of the 1st class, only stop once at the Newton bridge, to oil and examine the engine. Those of the second class take up and deposite passengers at only 12 points of the line; and in order to economize the time as much as possible, they are warned to be ready, with the cash, at the moment of getting out. The fare between the intermediate points, is fixed according to the distance, so that very little delay is caused.

The road was opened for use, from Liverpool to Manchester, on the 15th day of September, 1830, upon which occasion the Duke of Wellington, and many others of the most distinguished persons of England, were present. A magnificent car had been prepared for the Duke, Sir Robert Peel, Mr. Huskisson and others, which was drawn by the engine called the Northumberland. Seven other engines drew a similar number of cars, containing the rest of the party. The train departed and completed the journey to Parkside, seventeen miles from Liverpool, to the satisfaction of all, in fifty-six minutes. There they stopped to take in water, when the ceremonies were well nigh stopped by a most melancholy event. The Duke was conversing with Mr. Huskisson, who was standing in the centre of a group, near his carriage; when perceiving an engine advancing upon the track in which he stood, he as well as many others endeavored to regain the carriage. Mr. Huskisson, already suffering with lameness in one leg, was not quick enough, and was thrown down by th engine at the moment when he was between it and the open door. He fell with his left leg over the rail, when it was crushed, and he only survived the wound a few hours. The fear of the consequences which might ensue by disappointing the immense crowd assembled at Manchester, determined the Duke to proceed with the ceremonies, which were happily closed, and became the epoch of a new era, for the labour of England. Resuming the description of our journey at the moment when the cars are attached to the locomotive engine at Edge Hill, and when the engineer, opening the valves, puts them in motion, we will suppose the entrance to the station to be already passed.

We commence by enjoying the open prospect of a long portion of the road, curving gently to the left, on an exactly horizontal plane. The appearance of the road at this point, as in fact through its whole length, is agreeable to the eye, on account of its great regularity; it is of a handsome width, a little raised in the centre, and covered for a great part of its extent with gravel, smoothed with a rake. In the centre is placed the double line of rails, laid with mathematical precision. Thus arranged, the eve follows the line with-

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out any fatigue. From the Edge Hill summit the excavation through the lower side of the Hill, is in a continuation of free-stone, similar to that in which the tunnel terminates. Leaving Spekelands to the right, we soon arrive at the crossing of Wavertree lane; to the left is Plumbshall, the residence of C. Lawrence, and to the south is Wavertree and the Woolton hills. Here at the crossing of two roads, are two beautiful doors and a porter's lodge, constructed in an elegant manner. The route of the Rail Road, being furnished throughout with enclosing fences, where no natural defences exist, these gates are intended to close the ends, for the especial purpose of preventing animals from entering; similar gates are erected at all the road crossings; they are all neatly painted, and close by are built the lodges for the porters, who are chosen by the Company from those men, who have been maimed upon their works, or from among old and faithful domestics.

Mount Olive Cut.

After passing through the first gates, the road descends for a distance of about fi miles, at the rate of four feet per mile, and enter rapidly into an excavation, made to a great depth in marl, which soon severs the surrounding country from the sight, but which offers all the attraction of novelty, in compensation. We pass first five beautiful arched bridges, or viaducts, constructed for the purpose of passing the neighboring roads, similar to the others upon the line, to the number of sixty, and only differing from them in trifling matters; we then enter into a deep and frightful gulf, not less than *two miles* in length. Its appearance inspires melancholy, mingled with a sentiment of curiosity; we remark the perpendicular height of the sides of the road, and over head, through a confined space, is seen the blue vault of the sky. At intervals, this uniformity is broken by the sight of bridges of different constructions. One cannot refrain, upon emerging from this abyss, from casting a look behind, to see once more a scene, the singularity of which will often recall it to the memory. When lighted by a bright sunshine, it presents a striking and picturesque appearance, with its walls tapestried here and there with green moss, and the sight of human industry still obtaining from the earth the materials useful for the work. When passed at night, its natural obscurity is increased by a degree of light that only serves to make the darkness visible; the brilliant light from the fire-place of the engine, and from the lamps, glares rapidly upon different objects, causing them to throw a momentary shadow, instantly to relapse into the most profound gloom. A man, seen from the brink of this abyss from the bottom, appears so dwarfish, that the spectator is astonished at the work of his species, and is lost in the calculation of the number of hands, money, and contrivances employed to displace such an enormous mass of matter. In the deepest part, it is crossed by the bridge, over which passes the road between Wavertree and the Old Swan. The arch is of brick, but the natural rock still towers above to a considerable height. A little further on, two stone blocks, projecting towards each other, support a wooden bridge. Beyond this passage, the road goes through several large nurseries and under different bridges, built on different plans, the prospect, although agreeable, continues to be confined; but soon after the line reaches the level of the Roby road: we there pass another kind of crossing, into a wooded portion of country, leaving Olive Vale, the residence of

Mr. Swan, to the left, and arrive at the first embankment on the route, from which the view is unbounded; this is termed

The Broad Green Embankment.

This embankment, formed of the materials taken from the excavation of Mount Olive, is of different heights, from fifteen to forty-five feet, and from sixty to one hundred and thirty-five feet wide at the base. It is cut in many places by bridges, constructed for the passage of the roads, traversing the plain. At its highest elevation, the traveller overlooks the tops of the trees, and enjoys a prospect, highly interesting from its variety and immense extent.

We leave at first, at a little distance to the right, the village of Broad Green, almost concealed by a leafy screen; then on the left, is observed Summer Hill, the residence of Mr. Thomas Case; further on, is seen the Knowsely woods and the steeple of Prescot, rising from among the trees; directly in front, is the tower of Huyton Church; a little to the right is Roby; towards the south, is the richly wooded valley, stretching towards Runcorn, and upon the Woolton heights is the mill, Nether Woolton and Childwall, whilst in the rear is seen the Mount Olive glass house. After having passed the hamlet and domain of Roby, we arrive at a branch road, which conducts to a coal mine at a little distance to the right, of which the chimneys of the steam engine can be perceived. A little further to the left, and in a deep dell, quite near to the road, is a pottery. Here, the appearance of the country is highly interesting; beautiful farm houses occur on both sides of the road, which continues perfectly straight for more than two miles.

Having crossed the Huyton road, we arrive by a light curve, at the village of Whiston, distant seven and a half miles from Liverpool. Here we cross two bridges; the first of wood and the second of brick and stone, and of a single arch of forty-seven feet span. It is at this point that the Whiston inclined plane commences, which is readily observed by the relaxation of speed; its length is one mile and a half, the slope one foot in ninety-six, and the perpendicular height at the summit, eighty-two feet. In ascending this slope, we pass under many bridges built over the cuts. Arrived at the Rain Hill summit, which we traverse with renewed velocity, we pass under a bridge of the same name, built to pass the common road from Liverpool to Warrington, over the Rail Road; the direction of this bridge makes an angle of thirty-four degrees with the direction of the Rail Road, being the most beautiful on the route; having a single arch of fifty-four feet span, whilst the opening between the walls is only thirty-four feet.

From this summit, a glass house on the left attracts the attention; many coal mines have their branches ending at this point, not far from the spot where crosses the Rail Road from Runcorn to St. Helena. Upon the right is the residence of Mr. Bart. Brotherton.

After proceeding on a level for about two miles, we arrive at

The Sutton Inclined Plane.

The height, length and slope are the same as those of the Whiston plane. As upon the latter, many bridges have been thrown over it. The view, although confined, is not monotonous, as there is an open prospect in front, which attracts the eye. At the twelfth mile from Liverpool and upon this plane, the line is intersected by the common road from Bold to St. Helena. There is nothing interesting in the appearance of the country from the foot of this plane, to Parr-moss, which the road crosses. Upon arriving there, a sensation is experienced, indicating that the earth upon which we move is elastic, if it may be so called; the cars also cease to make as much noise as upon the firm ground. It is in some places twenty feet deep, and extends three quarters of a mile. The road has been formed of the materials taken from the excavation of the Sutton plane; it is raised from four to five feet above the surface of the marsh, which is already in a good train of cultivation, especially on that part, to the right of the line.

Leaving Barton wood on the same side, we arrive, at fourteen miles and a half distance from Liverpool, at

The Sankey Embankment and Viaduct.

The Sankey valley, of immense extent, and at the bottom of which is a canal, is crossed at this point by an embankment, formed of different materials mingled with brushwood, and is raised as much as seventy feet above the plain. This embankment conducts to a bridge, over the canal, having nine arches, each of fifty feet span, and built of brick, with the exception of the heads of the piers, which are of cut stone; the height from the parapets varies from sixty to seventy feet; the width at the surface of the road is twenty-five feet, and the piling for the foundations, driven to the depth of thirty feet, on account of the looseness of the soil, cost not less than forty thousand pounds sterling. The St. Helena canal passes under one of the arches, and the Sankey river under another. From the highest point of the bridge is seen to the left, the Newton race course, remarkable for its green sward and white cottages; to the south is Warrington church, and in the distance can be perceived the vessels under full sail in the canal; and to a very great distance the white sails can be seen, gleaming occasionally in the sun shine, showing the course of the canal, and the progress of the vessels on its waters.

On the fifteenth mile, another embankment commences, from which the prospect is also very fine. Near by, is the *old* town of Newton, which, however, is now only a little village, but which still enjoys the privilege of sending two deputies to parliament; here the embankment is forty feet high, and ends at a bridge of four arches, and thirty feet wide; under one of the arches the Warrington and Bolton post road passes, and under another, flows a stream strong enough to turn a mill.

Not far from this bridge, there still exists one of those gothic castles, which the English exert themselves so much to preserve, and which adds very much to the wild appearance of the environs.

A little beyond Newton, the main line is joined by the branch lines to Newton and to Wigan, and immediately after, the great Kenyon excavation commences, the work which has required the greatest labor. About seven hundred thousand cubic yards of sand and clay were excavated and used for the construction of the nearest embankments. Numbers of bridges have been built to unite the two banks; one of which, that might almost be called a tunnel, from its width, has been filled up above the arch with earth covered with sods; the road which passes over it, is secured on each side with wooden barriers. The view of a large bank of verdure in such a position, has something in it striking as well as agreeable. Towards the end of the excavation, the Kenyon and Leigh branch road joins the main line, by two tracks, one directing toward Liverpool and the other towards Manch

This road joins also with that of Bolton and Leigh, near the latter town. After passing under three bridges, we arrive at the domain of Culcheth, where is seen on the left the village of that name; and find ourselves on the Brosely embankment, about eighteen or twenty foot high, and about a mile and a half long.

Pursuing a rapid course over the embankment constructed on the low lands, bordering Chat Moss, we arrive over Bury lane, twenty-one miles from Liverpool. The village is situated in the deep woody dell on the left hand. Here, near the bridge over which we pass, is a hotel lately established, having its highest story on a level with the road. Beyond the village, is seen the ancient castle of Light-Oaks, surrounded by venerable trees. Proceeding onward, the embankment passes over the little stream called the Gless, and becomes more and more tremulous, being composed only of lumps of moss; we still see, however, on each side, a few scattered clumps of trees; but the vegetation rapidly disappears, and the traveller finds himself on the borders of the immense marsh, called

Chat Moss.

The road crosses towards the north, and in the widest part of this black and spongy waste, which nature appears to have stamped with barrenness. The width at the crossing place is four miles and three quarters; and for a quarter of a mile at each end, the embankment is now solid, but the remainder will hereafter swallow up a large quantity of material, especially in the deeper parts of the marsh, at the eastern end.

It was for a long time doubtful, whether it was possible to construct a road there, as it was by no means secure for the foot passenger; the depth being from twenty-four to thirty feet, and the superficies very great, it was impossible to use piles; but as the marsh was higher than some of the surrounding land, drains were made. To establish a foundation in the softest places, boughs, bushes, and bundles made of young branches, and vines woven together, were thrown in; the whole was covered with two or three feet of sand and gravel, as necessity required; and as soon as it was solid enough, the rails were laid down on wooden supports. At present, this part of the road not inferior to any other.

This swamp, is twelve miles square, and is calculated to contain sixty millions of tons of vegetable earth.

Upon entering this desolate waste, the appearance is cold and melancholy; but in the middle, it becomes more varied, and the view more extensive. On each side can be seen, at two miles distant, the carriages on the road; and the surrounding country presents an agreeable panorama. On the north, can be distinguished the peak of Rivington, surrounded by mist; and in fine weather Black Stone Edge can be seen in front; a little to the left is Tildsley church with its gothic steeple; and a little beyond, the village of Astley; further on, to the east, upon a wooded eminence, stands Worsley castle, belonging to Mr. R. H. Bradshaw, who has established in the marsh and near the road, a plantation, of birch and other trees, to which he has given the name of Botany Bay. On the east, the country is richly wooded, and on the right a manufactory, situated at Patri Croft, shows its walls, pierced with numerous windows, and surmounted by a bell; and on the south, the marsh is surrounded with a girdle of trees, in the bosom of which are many farms. In the same direction, after passing the twenty-fourth mile, it may be seen that a great part has been put under cultivation. Long avenues of trees newly planted, divide the ground, and on the borders of one farm, many houses have been erected. One of these is the residence of Mr. Reed, director of an extensive and productive farm, entirely reclaimed from a spot formerly abandoned.

This establishment owes its existence to several enterprising persons, who have constructed a private Rail Road, leading from the principal line, as far as the river Irwell, crossing at about two miles the Warrington and Manchester road, at eight miles from the latter town. Two hundred acres of land have been reclaimed in eighteen months; wheat of as good quality, as can be found elsewhere in the county, was collected in 1830, from twenty acres, in addition to eight acres of beans, and twenty acres of apples, of superior quality. The road, of which we have just spoken, is constructed with moveable rails, twelve feet in length, resting on wooden supports; their place is changed according to the direction to be given to the cars, carrying the marl, for the preparation of the soil. The earth is divided into different portions by deep cuts, in which smaller ones are made, covered over with turf, and receiving the superabundance of water from the upper layer. This farm is an example, which will tend, sooner or later, to encourage the cultivation of the remainder of the marsh.

The road beyond Chat Moss gradually rises upon the Barton embankment, from which a rich country is seen, forming a pleasing contrast, with the dreary desert just passed. As we advance, the attention is kept alive. First we arrive at Patri Croft, seen for a long time in the distance, and beyond by a bridge of three arches, we cross The Duke's canal. We then enter into an excavation, varying in depth. After the twenty-seventh mile, we pass under a bridge to the north of Eccles, a village famous for its good cakes and its bells; and after passing several wooden bridges, we see on the right two handsome old buildings, surrounded by trees, and in the distance, directly in front, is Manchester, known by the steeple of St. Michael's church. At the place called the Waste lane dye works, the road passes under six stone bridges, many of which are for the passage of the streets; the last is intended for the passage of the narrow lane from Oldfield to

Salford. Upon leaving the excavation, and a little to the right, we see a building used as a coach house for the Rail Road cars; and further still, is the engineer's office. Finally, upon an embankment, from which Manchester and Salford can be seen to the north, the ear is struck with the noise of a commercial city; we cross the Irwell, and find ourselves at the Company's station, with a long row of stores directly in front. At this point the road is considerably raised above the banks of the river, upon the Manchester side; the width is increased, the rails are doubled in number, and it continues for a great distance, in a direction parallel to the common road to Liverpool, over a succession of twenty-two brick arches, and a bridge thrown over Water street, and ends at the great coal station, forming an angle to the left. At this end of the line, the rails have wooden supports; and the coal cars discharge their loads above the spot intended to receive them. The arches over which the road passes, upon its first entrance, are appropriated to different trades; those nearest to the river are used for dying shops. An engine is located at this place, which pumps up the water for the locomotive engines, from a cistern, fifteen feet deep.

The bridge over the Irwell is of stone; the arches are of sixty-three feet span, and thirty feet high above the river. It has been prepared to receive, besides the Rail Road, another road for the use of the Old Dock Company. The bridge over Water street is supported, partly by cast iron pillars, separated by brick arches, and partly by eleven doric columns, on each side of the passage below. Its height is seventeen feet and a half, and the cast iron used in its construction, weighs forty-five tons. The parapet is also cast, enriched with pilasters. The Rail Way is on a level with the second floor of the magazines, in which the cars can be introduced by six large doors, so as to be loaded or unloaded under cover. The second front of this vast range of store houses, looks upon Water street, with which the basement story is on a level.

On the opposite side of the stores and of the Rail Way, is a spacious building, with a Grecian front, facing the Liverpool turnpike road. It is intended for the reception of travellers, who pass through it, when alighting from or repairing to the cars.

Having now arrived at the end of our journey, we will not describe the city of Manchester, whose products are too well known to need description. One, however, would never suppose, upon seeing the number of trades now carried on there, amounting to thirty thousand, that in 1814, it contained not a single one. It must be acknowledged that it has acquired this prosperity since the peace, from the numerous avenues which have been opened to it; but who can set bounds to this increase, if it had enjoyed from that time, the economy of time and money, which it now receives from the communication with Liverpool? Experience will not fail to resolve this question; and it is on experience alone that we must depend, to dissipate the doubts and objections raised on all sides, and which the general use of Rail Roads can alone set to rest.

Conclusion.

We will state, in conclusion, some particulars respecting the formation of the Liverpool and Manchester Rail Road Company.

In the year 1822, Mr. James, an Engineer, conceived and communicated the idea of this road to Mr. Sandars. This latter person took up the idea, and caused a preparatory survey to be made, the expense of which he took upon his own guaranty. The first line laid out, was not the one afterwards adopted by the Company. A quantity of indispensable information was necessary, in order to fix definitely the plan, which the roads of Newcastle upon Tyne, and of Sunderland could not furnish. It was not until the 20th day of May, 1824, that Mr. Sandars published his first report; and at the same time, a declaration was signed by a hundred and fifty merchants, purporting that the means of communication between Liverpool and Manchester had become insufficient. After having made a second location, and collected together a sufficient number of subscribers, the committee appointed for the purpose, published on the 24th of October its definite report.

In the beginning of the year 1825, many members of the Committee repaired to London for the purpose of soliciting a bill, authorizing the Company to purchase the land and commence operations. A strong opposition was expected, and was in fact made by the proprietors of the Duke of Bridgewater's canal, of the Mersy and Irwell canal, and the Leeds and Liverpool canal. To this was joined the opposition of the Counts Derby and Sefton, whose grounds were cut by the line of the road. Unfortunately this opposition prevailed, and the bill was withdrawn. The committee, however, not discouraged, persevered in its resolution. Gaining experience from this defeat, they published a new report, creating funds to the amount of 510,000 pounds sterling, announcing also that the Marquis of Stafford, one of the Directors of the Bridgewater canal, took a thousand shares, and that the new line would not touch the properties of the Counts Derby and Sefton; and at the same time replying to other objections raised against it. A new bill passed both houses of Parliament in April, 1826. The Company definitely organized, collected in a general meeting on the following month, and appointed two directors to act conjointly with three others, appointed by the Marquis of Stafford. At a meeting of the Directors, held the next day, Mr. Stephenson, whose talents and great practical knowledge had been duly appreciated in the preparatory operations, was appointed Chief Engineer. Actual operations were commenced in June, 1826. On the 15th of July, the construction of the Irwell bridge was commence[illegible] the last of the great works, and on the 15t[illegible]

September, 1830, the road was opened for use. The following is a statement of the sums expended, and of those which may still be necessary to perfect the work.

	£	s.	d.
To Publications, . .	322	1	4
To manufacture of Bricks,	9,724	4	4
To building sixty-three Bridges,	99,065	11	9
To expenses of Directors,	1,911	"	"
To enclosures, ...	10,202	16	5
To repairs of carriages, .	461	6	3
To Chat Moss, ...	27,719	11	10
To deep cuts and terraces,	199,763	8	"
To purchase of land and buildings at Liverpool, . .	38,028	"	"
To purchase of land and buildings at Manchester, . .	6,159	"	"
To gasometers, gas pipes, &c.	1,046	"	"
To engines, tenders, &c. .	10,991	11	4
To grading the road, . .	20,568	15	5
To Iron Rails, ...	67,912	"	2
To interest of loans, . .	3,629	16	7
To purchase of land for the road,	95,305	8	8
To offices for Company, .	4,939	8	5
To expenses in Parliamentary business, ...	28,465	6	11

	£	s.	d.
To stone blocks and wooden sleepers, ...	20,520	14	5
To expenses of engineers,	19,829	8	7
To travelling expenses, .	1,423	1	5
To tunnel, ...	34,791	4	9
To extra expenses of tunnel,	9,977	5	7
To cars, ...	24,185	5	7
To sundries, ...	2,227	17	3
To sloping and repairing road way,	6,750	"	"
To finishing bridges and damages,	9,500	"	"
To supplementary engines,	17,000	"	"
To construction of stationary engines, &c.	25,000	"	"
To new enclosures and fences,	3,000	"	"
To contingent expenses, .	12,084	15	"
To completion of contracts, .	7,500	"	"
	£820,000		

When the Company published their first report, they announced that the sum of £400,000 st. would be sufficient to cover all expenses. In the second report, and after the location of the new line, the capital was increased to £570,000 st. but we see that the actual cost exceeded this estimate by more than one half, being as before stated £820,000 st. One would suppose, that the cost being double that which was first estimated, the Company would be mistaken in their expectation of deriving any profit from it; but it has not been so; for by the accounts rendered at the close of the year 1830, the stockholders have doubled their capital, and drawn at the same time £8 st. of interest.

This result shows, that in making the calculations of the profits, the directors have wisely taken for their base, the lowest sum of the anticipated receipts. It is to be hoped that the same wise principle will guide all Companies in their calculations, having before their eyes the immense unexpected expense, which the Liverpool and Manchester Company have been forced to undergo.

FINIS.

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Lo Private Carriage.

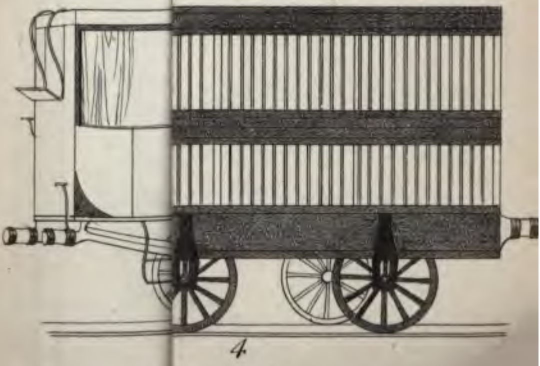

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Fig. IV.

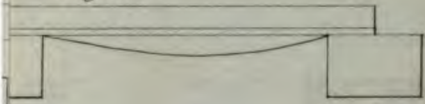

Fig. VI.

Fig. V.

Pl. II